

What is claimed is:

1. An optical glass comprising, in mass percent:

$P_2O_5$	15 – 35%
$Nb_2O_5$	40 – 60%
$Na_2O$	0.5% to less than 15% and
$BaO$	3% to less than 25%;

having a ratio in mass % of  $(BaO + Nb_2O_5)/\{(TiO_2 + WO_3) \times 3 + Bi_2O_3 + Nb_2O_5\}$   $> 1.0$ ; being free of Pb and As; and having a refractive index (nd) within a range from 1.78 to 1.90 and an Abbe number ( $\nu_d$ ) within a range from 18 to 27.

2. An optical glass as defined in claim 1 further comprising, in mass %:

$Gd_2O_3$	0 – 5% and/or
$K_2O$	0 – 10% and/or
$Li_2O$	0 – 10% and/or
$Bi_2O_3$	0 – 5% and/or
$MgO$	0 – 10% and/or
$CaO$	0 – 10% and/or
$SrO$	0 – 10% and/or
$ZnO$	0 – 3% and/or
$SiO_2$	0 – 5% and/or
$B_2O_3$	0 – 5% and/or
$Al_2O_3$	0 – 4% and/or
$Ta_2O_5$	0 – 5% and/or
$ZrO_2$	0 – 3% and/or
$TiO_2$	0 – 5% and/or
$WO_3$	0 – 8% and/or
$Sb_2O_3$	0 – 0.02%.

3. An optical glass as defined in claim 1 which, in X – Y rectangular co-ordinates with X-axis representing ISO Color Contribution Index G calculated by using spectral transmittance of a glass material measured by the Japan Optical Glass Industry Standard JOGIS02-1975 (Measuring Method for Degree of Coloring of Optical Glass) and Y-axis representing refractive index (nd), is within an area having a smaller value of ISO Color Contribution Index G and a higher refractive index (nd) than a straight line (SL3 – G) :  $Y = 0.0277X + 1.725$  and which, in X – Y rectangular co-ordinates with X-axis representing ISO Color Contribution Index R calculated by using spectral transmittance of a glass bulk measured by the Japan Optical Glass Industry Standard JOGIS02-1975 and Y-axis representing refractive index (nd), is within an area having a smaller value of ISO Color Contribution Index R and a higher refractive index (nd) than a straight line (SL3 – R) :  $Y = 0.0273X + 1.7102$ .

4. An optical glass as defined in claim 1 wherein the sum of sectional areas of bubbles contained in glass of 100ml shown in Table 1 of the Japan Optical Glass Industry Standard JOGIS12-1994 (Measuring Method for Bubble in Optical Glass) is Class 1 – Class 4 and the sum of sectional areas of inclusion contained in glass of 100ml shown in Table 1 of the Japan Optical Glass Industry Standard JOGIS13-1994 (Measuring Method for Inclusion in Optical Glass) is Class 1 – Class 4.

5. An optical glass as defined in claim 1 which, in X – Y rectangular co-ordinates with X-axis representing ISO Color Contribution Index G calculated by using spectral transmittance of a glass material measured by the Japan Optical Glass Industry Standard JOGIS02-1975 (Measuring Method for Degree of Coloring of Optical Glass) and Y-axis representing refractive

index (nd), is within an area having a smaller value of ISO Color Contribution Index G and a higher refractive index (nd) than a straight line (SL5 - G) :  $Y = 0.0329X + 1.7174$  and which, in X - Y rectangular co-ordinates with X-axis representing ISO Color Contribution Index R calculated by using spectral transmittance of a glass bulk measured by the Japan Optical Glass Industry Standard JOGIS02-1975 and Y-axis representing refractive index (nd), is within an area having a smaller value of ISO Color Contribution Index R and a higher refractive index (nd) than a straight line (SL5 - R) :  $Y = 0.0288X + 1.713$ .

6. An optical glass as defined in claim 1 comprising, in mass percent:

$P_2O_5$	15 - 35%
$Nb_2O_5$	40 - 60%
$Na_2O$	0.5% to less than 15% and
$BaO$	3% to less than 25%;

and further comprising, in mass %:

$Gd_2O_3$	0 - 4% and/or
$K_2O$	0 - 6% and/or
$Li_2O$	0% to less than 6% and/or
$Bi_2O_3$	0% to less than 5% and/or
$MgO$	0% to less than 10% and/or
$CaO$	0% to less than 10% and/or
$SrO$	0% to less than 10% and/or
$ZnO$	0 - 3% and/or
$SiO_2$	0 - 5% and/or
$B_2O_3$	0 - 5% and/or
$Al_2O_3$	0 - 4% and/or
$Ta_2O_5$	0 - 5% and/or
$ZrO_2$	0 - 3% and/or

$\text{Sb}_2\text{O}_3$  0 – 0.02% and/or

$\text{TiO}_2$  0 – 5% and/or

$\text{WO}_3$  0 – 8% and/or

a fluoride or fluorides of a metal element or elements

contained in the above metal oxides, a total amount of F

contained in the fluoride or fluorides 0 – 5%; and

having a ratio in mass % of  $(\text{BaO} + \text{Nb}_2\text{O}_5)/\{(\text{TiO}_2 + \text{WO}_3) \times 3 + \text{Bi}_2\text{O}_3 + \text{Nb}_2\text{O}_5\}$   
 $> 1.0$ .

7. An optical glass as defined in claim 1 comprising, in mass percent:

$\text{P}_2\text{O}_5$  15 – 35%

$\text{Nb}_2\text{O}_5$  40 – 60%

$\text{Na}_2\text{O}$  0.5% to less than 15% and

$\text{BaO}$  3% to less than 25%;

and further comprising, in mass %:

$\text{Gd}_2\text{O}_3$  0.1 – 4% and/or

$\text{K}_2\text{O}$  0 – 6% and/or

$\text{Li}_2\text{O}$  0% to less than 6% and/or

$\text{Bi}_2\text{O}_3$  0% to less than 4.5% and/or

$\text{MgO}$  0% to less than 10% and/or

$\text{CaO}$  0% to less than 10% and/or

$\text{SrO}$  0% to less than 10% and/or

$\text{ZnO}$  0 – 3% and/or

$\text{SiO}_2$  0% to less than 5% and/or

$\text{B}_2\text{O}_3$  0% to less than 5% and/or

$\text{Al}_2\text{O}_3$  0 – 4% and/or

$\text{Ta}_2\text{O}_5$  0 – 5% and/or

$\text{ZrO}_2$  0 – 3% and/or

$\text{Sb}_2\text{O}_3$  0 – 0.01% and/or

TiO<sub>2</sub> 0 – 5% and/or

WO<sub>3</sub> 0 – 8% and/or

a fluoride or fluorides of a metal element or elements

contained in the above metal oxides, a total amount of F

contained in the fluoride or fluorides 0 – 5%; and

having a ratio in mass % of  $(\text{BaO} + \text{Nb}_2\text{O}_5)/\{(\text{TiO}_2 + \text{WO}_3) \times 3 + \text{Bi}_2\text{O}_3 + \text{Nb}_2\text{O}_5\}$   
> 1.0.

8. An optical glass as defined in claim 1 which, in X – Y rectangular co-ordinates with X-axis representing ISO Color Contribution Index G calculated by using spectral transmittance of a glass material measured by the Japan Optical Glass Industry Standard JOGIS02-1975 (Measuring Method for Degree of Coloring of Optical Glass) and Y-axis representing refractive index (nd), is within an area having a smaller value of ISO Color Contribution Index G and a higher refractive index (nd) than a straight line (SL8 – G) :  $Y = 0.0329X + 1.7245$  and which, in X – Y rectangular co-ordinates with X-axis representing ISO Color Contribution Index R calculated by using spectral transmittance of a glass bulk measured by the Japan Optical Glass Industry Standard JOGIS02-1975 and Y-axis representing refractive index (nd), is within an area having a smaller value of ISO Color Contribution Index R and a higher refractive index (nd) than a straight line (SL8 – R) :  $Y = 0.0288X + 1.7208$ .

9. An optical glass as defined in claim 1 comprising, in mass percent:

P<sub>2</sub>O<sub>5</sub> 15 – 30%

Nb<sub>2</sub>O<sub>5</sub> 42 – 60%

Na<sub>2</sub>O 0.5% to less than 10% and

BaO 5% to less than 25%;

and further comprising, in mass %:

Gd <sub>2</sub> O <sub>3</sub>	0.1 – 4% and/or
K <sub>2</sub> O	0 – 6% and/or
Li <sub>2</sub> O	0 – 2% and/or
Bi <sub>2</sub> O <sub>3</sub>	0% to less than 4.5% and/or
MgO	0% to less than 10% and/or
CaO	0% to less than 10% and/or
SrO	0% to less than 10% and/or
ZnO	0 – 3% and/or
SiO <sub>2</sub>	0.1% to less than 4% and/or
B <sub>2</sub> O <sub>3</sub>	0.2% to less than 5% and/or
Al <sub>2</sub> O <sub>3</sub>	0 – 4% and/or
Ta <sub>2</sub> O <sub>5</sub>	0 – 5% and/or
ZrO <sub>2</sub>	0 – 3% and/or
Sb <sub>2</sub> O <sub>3</sub>	0 – 0.01% and/or
TiO <sub>2</sub>	0 – 3% and/or
WO <sub>3</sub>	0 – 5% and/or

a fluoride or fluorides of a metal element or elements

contained in the above metal oxides, a total amount of F

contained in the fluoride or fluorides 0 – 5%; and

having a ratio in mass % of  $(\text{BaO} + \text{Nb}_2\text{O}_5) / \{(\text{TiO}_2 + \text{WO}_3) \times 3 + \text{Bi}_2\text{O}_3 + \text{Nb}_2\text{O}_5\}$   
 $> 1.1$ .

10. An optical glass comprising, in mass percent:

P <sub>2</sub> O <sub>5</sub>	15 – 35%
Nb <sub>2</sub> O <sub>5</sub>	40 – 60%
Gd <sub>2</sub> O <sub>3</sub>	0.1 – 4%
Na <sub>2</sub> O	0.5% to less than 10%
K <sub>2</sub> O	0 – 6%

where the total amount of Na<sub>2</sub>O and K<sub>2</sub>O is 0.5% to less than 10%

$\text{Bi}_2\text{O}_3$	0% to less than 5%
$\text{MgO}$	0% to less than 10%
$\text{CaO}$	0% to less than 10%
$\text{SrO}$	0 to less than 10%
$\text{BaO}$	0.5% to less than 25%
$\text{ZnO}$	0 – 3%
$\text{SiO}_2$	0% to less than 5%
$\text{B}_2\text{O}_3$	0.2% to less than 5%
$\text{Al}_2\text{O}_3$	0 – 3%
$\text{Ta}_2\text{O}_5$	0 – 5%
$\text{ZrO}_2$	0 – 3%
$\text{Sb}_2\text{O}_3$	0 – 0.03%

and a fluoride or fluorides of a metal element or elements  
 contained in the above metal oxides, a total amount of F  
 contained in the fluoride or fluorides 0 – 5%;

being free of  $\text{Pb}$ ,  $\text{WO}_3$  and  $\text{TiO}_2$  and having a refractive index ( $n_d$ ) within a  
 range from 1.78 to 1.90 and an Abbe number ( $\nu_d$ ) within a range from 18 to  
 27.

11. An optical glass comprising, in mass percent:

$\text{P}_2\text{O}_5$	15 – 30%
$\text{Nb}_2\text{O}_5$	42 – 60%
$\text{Gd}_2\text{O}_3$	0.1 – 4%
$\text{Na}_2\text{O}$	0.5 – 9.6%
$\text{K}_2\text{O}$	0 – 6%
where the total amount of $\text{Na}_2\text{O}$ and $\text{K}_2\text{O}$ is 0.5% to 9.6%	
$\text{Bi}_2\text{O}_3$	0 – 4.5%
$\text{MgO}$	0% to less than 10%
$\text{CaO}$	0% to less than 10%

SrO	0% to less than 10%
BaO	0.5% to less than 25%
ZnO	0 – 3%
SiO <sub>2</sub>	0.1% to less than 4%
B <sub>2</sub> O <sub>3</sub>	0.2% to less than 5%
Al <sub>2</sub> O <sub>3</sub>	0 – 3%
Ta <sub>2</sub> O <sub>5</sub>	0 – 5%
ZrO <sub>2</sub>	0 – 3%
Sb <sub>2</sub> O <sub>3</sub>	0 – 0.03%

and a fluoride or fluorides of a metal element or elements  
 contained in the above metal oxides, a total amount of F  
 contained in the fluoride or fluorides 0 – 5%;

being free of Pb, WO<sub>3</sub> and TiO<sub>2</sub> and having a refractive index (nd) within a range from 1.78 to 1.90 and an Abbe number ( $\nu_d$ ) within a range from 18 to 27.

12. An optical glass as defined in claim 1 wherein the sum of sectional areas of bubbles contained in glass of 100ml shown in Table 1 of the Japan Optical Glass Industry Standard JOGIS12-1994 (Measuring Method for Bubbles in Optical Glass) is Class 1 – Class 3, the sum of sectional areas of inclusion contained in glass of 100ml shown in Table 1 of Japan Optical Glass Industry Standard JOGIS13-1994 (Measuring Method for Inclusion in Optical Glass) is Class 1 – Class 3, and the degree of striae shown in Table 2 of the Japan Optical Glass Industry Standard JOGIS11-1975 (Measuring Method for Striae in Optical Glass) is Class 1 – Class 3.

13. An optical glass as defined in claim 1 wherein the degree of striae shown in Table 2 of the Japan Optical Glass Industry Standard JOGIS11-1975 (Measuring Method for Striae in Optical Glass) is Class 1 or Class 2, the sum



of sectional areas of bubbles contained in glass of 100ml shown in Table 1 of the Japan Optical Glass Industry Standard JOGIS12-1994 (Measuring Method for Bubble in Optical Glass) is Class 1 or Class 2, and the sum of sectional areas of inclusion contained in glass of 100ml shown in Table 1 of Japan Optical Glass Industry Standard JOGIS13-1994 (Measuring Method for Inclusion in Optical Glass) is Class 1 or Class 2.

14. An optical glass as defined in claim 1 having a refractive index ( $n_d$ ) within a range from 1.80 to 1.85 and an Abbe number ( $\nu_d$ ) within a range from 23.8 to 25.7.